A carbon receive array of 8 elements, interoperable with proton scanning, for human temporal lobe

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Introduction: The diagnostic potential of metabolic imaging with hyperpolarized ^{13}C has been established through many animal studies (*1, 2*); but the extension to clinical trials requires suitable hardware, specifically probes. We have earlier reported the development of a dual tuned ^{13}C -^{1}H endorectal receive coil, for carbon metabolic imaging of human prostate (*3*), and also a volume transmitter for human studies, in clamshell geometry, with a hinged entry to facilitate patient loading (*4*). We here expand that effort, and present a bilateral receive array of eight elements for ^{13}C of human temporal lobe, with proton blocking for interoperability with proton scanning.

Results and Discussion: The individual resonant loops are laid out in a conventional overlapped pattern, as illustrated in Figure 1, which shows a preliminary design test of residual inter-element coupling. The final circuit was etched on copper clad Teflon substrate (RT Duroid™). The underlapped configuration we used earlier (4) is abandoned due to the difficulty of suppressing radiofrequency ground loops when on-board preamps are installed. Each loop has an individual proton trap circuit, and impedance matching on the coil, to minimize extraneous circulating currents en route to the preamplifiers. Two constellations of 4 loops each are placed individually in polyurethane paddles (Figure 2.) External circuit boards – shown exposed in Figure 2, house the ^{13}C preamplifiers, and contain the individual tuning elements (per coil) to insure that impedance inversion occurs between the preamp input and the drive port of the actual coil (4). Typical results of bench test give input reflection (return loss in the range of -10 to -12 dB, and near neighbor isolation on the order of -12 dB, with physiological loading.

For imaging, the two paddles locate on either side of a special head holder, residing inside the volume transmit coil (in this case with a clamshell hinge, as noted above), the whole assembly affixed to a dedicated patient cradle, as shown in a CAD model (Figure 3) and in actual preparation for a phantom scan (Figure 4). Figure 5 shows chemical shift image (CSI) results from a single coil, on a oil phantom, roughly head shaped. The in plane resolution is 1 cm; usable spectra are seen in this instance to a depth of 3 cm; with hyperpolarized substrate, the usable penetration may reach 4 cm, or possibly 5, when results from neighboring coils are combined. Complete interoperability with proton scanning is allowed, since the transmitter and receiver are both passively proton blocked. Low resolution proton scans may be acquired on the system body coil (Figure 5), with full carbon TRX complement in place. For high resolution proton scanning, the carbon RX paddles may be removed, and a proton receive array slid into place over the head holder, without disturbing the patient position.

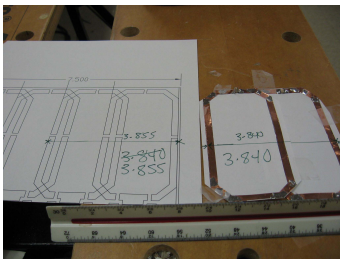

Figure 1: Preliminary layout of loop pattern, and copper tape models.

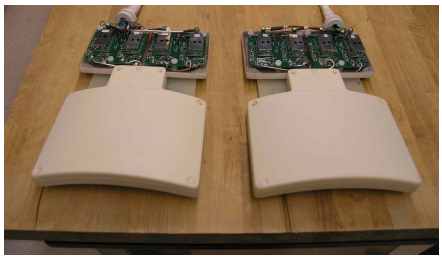

Figure 2: Paddles showing with drive circuit boards exposed

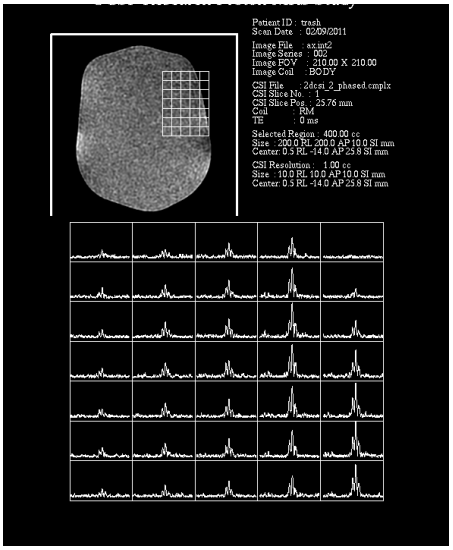

Figure 5: CSI oil phantom results for single coil, with grid overlaid on proton image of phantom, acquired with system proton body coil.

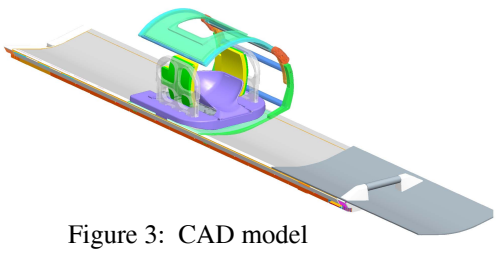

Figure 3: CAD model showing paddles (yellow-green) installed about head holder (purple) inside TX coil (blue-green)

Figure 4: Imaging set up with oil phantom and paddles loaded in head holder, all inside TX coil.

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2. M. J. Albers et al., Cancer Res., **68** 8607 (2008).
3. J. Tropp et al. Proceedings ISMRM 2594 (2006).
4. J. Tropp et al. J. Magn. Reson. **208** 171 (2011).